

Sea Level Rise: Delaware's Rising Tide



Here's what DNREC is doing to plan for and manage the effects of sea level rise in the First State, both now and in the not too distant future.

BY KELLY VALENCIK

OVER THE PAST FEW YEARS, Herbert Abbott has noticed that lotus lilies are no longer growing in the St. Jones River across the road from his house. Throughout his more than 90 years living in downtown Dover, from childhood to his adult life, the flowers used to bloom there every summer. But recently, they have not appeared in that same spot. Since the lotus lilies can only grow in fresh water, Mr. Abbott is concerned that an increase in the amount of salt water entering the river from the Delaware Bay is having an effect on their

native habitat. Could this salt water intrusion be due to rising sea levels?

In the coastal town of Bowers Beach, Mayor Ron Hunsicker understands that by living where he does, flooding is a fact of life. "We understand that we're going to be flooded; we're in a low, coastal area. But the level of flooding and the frequency of flooding have increased dramatically over the last 10 years." Mayor Hunsicker worries about protecting his town from this type of coastal hazard, but lately, it hasn't been easy. A particularly harsh Nor'easter on Mother's Day in

2008 triggered the biggest flooding event he's seen in years. "What was so devastating about that one was the quickness that it came - that it was so unexpected," he remembers. Could this increase in coastal storm damage be due to rising sea levels?

Aerial photographs taken of the Blackbird Creek in the Delaware National Estuarine Research Reserve near Townsend over time show a striking difference in the creek: it has grown significantly wider over the past few decades. Researchers who work in the wetlands surrounding the creek have



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Coastal flood waters cover the waterfront docks and businesses in Bowers Beach during a November 2009 Nor'easter.

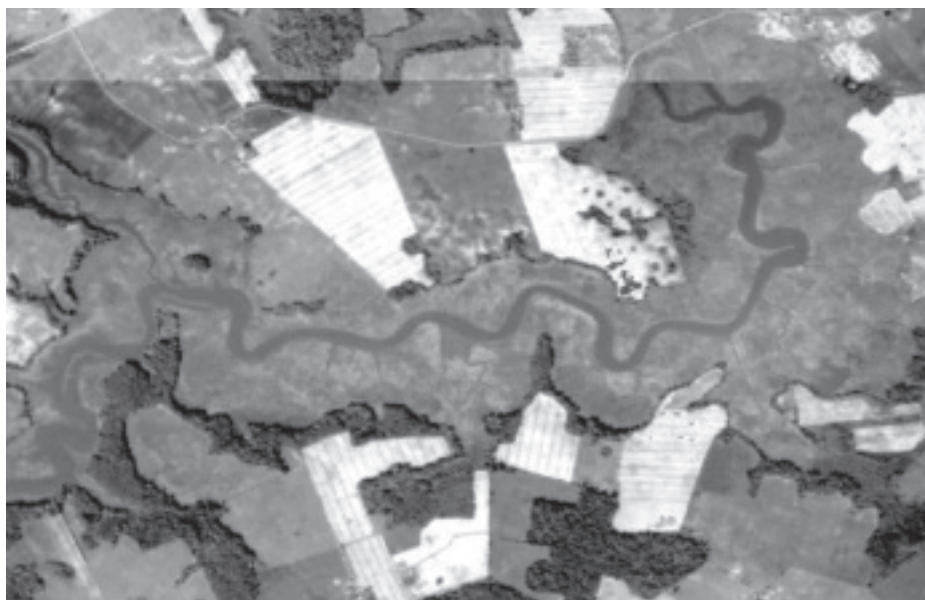


ERIC CROSSAN

Blackbird Creek in July 2009. This aerial view shows significant widening and loss of marsh grasses.

noticed that the areas of marsh grass that once lined the shores have disappeared, replaced by areas of open water. Without a buffer zone of marsh grasses on the banks of the river to absorb runoff, pollutant levels in the creek could sharply increase. Could this increase in inundation (water covering normally dry land) be due to rising sea levels?

What these recently occurring situations have in common is that they are all examples of the possible future effects of sea level rise throughout the First State. Experts worldwide agree that sea level is rising across most of the United States coastline and around the world, including Delaware. While it is impossible to know with certainty whether sea level rise is the main culprit for the disappearing lotus flower, flooding in Bowers Beach and loss of marsh in the Blackbird Creek, these three examples



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An aerial view of the Blackbird Creek in Townsend from 1937.

highlight the types of impacts Delaware residents could see more frequently as sea levels rise. They also highlight three of the main impacts that state scientists and planners are preparing for: saltwater

intrusion, increased coastal storm damage and coastal inundation.

Sea Level Rise: An Old Story

Sea level rise is nothing new. The levels

What Delawareans are thinking about climate change and sea level rise:

- **79%** of Delaware residents strongly or moderately agree that scientists are right that climate change is occurring.
- **75%** of Delaware residents strongly or moderately agree that climate change is contributing to sea level rise.
- **65%** of Delawareans support avoiding building new structures in areas at risk from sea level rise and support changing building codes and regulations to reduce risk in flood prone areas.
- **80%** of Delawareans think that (regardless of how many years they believe it will take for sea level rise to affect their area) action should be taken to address or reduce the impacts of sea level rise before impacts occur.
- **64%** of Delawareans support spending more money on public construction projects if it means that the structures could withstand or accommodate sea level rise in Delaware.

Source: Delaware Residents' Opinions on Climate Change and Sea Level Rise, produced for the Delaware Department of Natural Resources and Environmental Control by Responsive Management, 2010.



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Coastal flooding during an October 2009 Nor'easter completely saturated the marshes and inundated Old Corbitt Road near Odessa. Roadways in low lying areas such as this will need to be either raised or abandoned in the future as sea level rise increases the severity of flooding events.

of the ocean, bays and rivers have risen and fallen throughout the earth's history as a result of natural warming and cooling cycles. Repeated ice ages have resulted in sea level fluctuations up to 460 feet along the mid-Atlantic region. Over the past 2,000 years, sea level has been relatively stable. Data from a NOAA water level gauge in Lewes collected

from 1919 to 2006 shows that average sea level increased about .13 inches every year. At first glance, that may not seem significant, but added over time, this rate equals more than a foot of sea level rise in Delaware over the past 100 years. The problem is that scientists believe this current rate of sea level rise will likely accelerate because of global climate change.

Worldwide temperatures have been increasing since the Industrial Revolution; increased temperatures since the middle 20th century are very likely due to an increased level of emissions of greenhouse gases from activities such as electricity generation and car emissions. During periods of climatic warming such as this, two major processes can cause sea level rise. First, as water warms, it expands slightly, and increases its volume. Second, warmer water also can melt land reservoirs of glaciers and icecaps, which contributes additional water to the oceans.

Both the Intergovernmental Panel on Climate Change and the U.S. Climate Change Science Program have concluded that with this climatic warming, it is very likely that the rates of sea level rise will increase. Based on the projections of these scientists, surrounding states and federal agencies are planning for sea level to increase anywhere from one foot to five feet or more by 2100.

These changes could have major impacts on our state. In Delaware's Bombay Hook National Wildlife Refuge, just over three feet of sea level rise will flood the road that separates the tidal marsh from Raymond and Shearness



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Dune loss along Bowers Beach due to another Nor'easter in November 2009.



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marshes in Kent and Sussex Counties, which may permanently become areas of open water.

Coastal inundation like this is already occurring in Bombay Hook National Wildlife Refuge. Since 1979, the refuge has lost a total of 12 percent of its wetland area from a combination of sea level rise, erosion and other causes. Blackbird Creek's wetlands already show signs of this too; once vegetated areas along its shores are now areas of open water. Increased inundation levels can also increase flooding risks, making existing homes, buildings and infrastructure that have never experienced tidal flooding from coastal storms more vulnerable.

More Coastal Storm Damage

It is more important than ever for Dela-

A and Walnut Streets in Wilmington, after a Nor'easter in November 2009.

Pools, inundating the adjacent wetlands and forest and changing the habitat that Bombay Hook is renowned for. Without any intervention, the average higher high water line could actually reach the Bombay Hook Refuge Headquarters and Visitors Center. At about five feet of sea level rise, the entire refuge headquarters would be under water, including most of the habitat at the refuge.

Elsewhere across the state, three feet of sea level rise would completely inundate almost the entire length of Bowers Beach Road within town limits – eliminating access to the only road in or out of the town. Additionally, sea level rise could have significant impacts on Wilmington, including the Port of Wilmington, one of Delaware's most important economic resources. At only 1.5 feet of sea level rise, one of two dry storage areas will be flooded, as would five of six cold storage facilities and the majority of the container terminal. Moreover, three feet of sea level rise would flood the parking lot for the Blue Rocks' Frawley stadium and the Chase Center.

Increased Coastal Inundation

Delaware's gently sloping coastal plain makes our state more vulnerable than



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Coastal flooding in the town of Little Creek along its main thoroughway – Route 9 – during a November 2009 Nor'easter.

other areas to sea level rise. As sea levels rise, high tide lines will push farther inland, and the flatter the land, the more extensive the inland movement will be. In developed areas it is likely that people will be able to build up structures to protect themselves from rising sea levels, but it will be much harder to protect vast expanses of natural areas such as the tidal

wareans to pay attention to how sea level rise may impact our state. Although sea levels have risen and fallen in the past, modern human development has altered the coastline so much that it can no longer adapt naturally to these changes as it once did without consequence.

Between 2000 and 2007, about 30,000 people moved to Sussex County



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Shoreline erosion along Bowers Beach due to an early fall Nor'easter in September 2009. Storm surge pushes the water toward land. When it retreats, it takes some of the beach with it. As sea level rises, the height of storm surges will also increase and could possibly inundate areas never prone to flooding before.

and about 25,000 people moved into Kent County, spurring residential and commercial development. This influx increases the number of homes, businesses and supporting infrastructure that may be affected by rising seas. This, in turn increases the potential cost of protecting residents from its effects. The residents of Bowers Beach have found out first hand what increased sea levels coupled with coastal storms can do to homes and other structures that stand in the way. Yet like elsewhere in Delaware, the town's economy and cultural heritage are intrinsically tied to being in close proximity to the coastline.

It is important for coastal planners and residents to realize that the extreme levels of coastal storm flooding that they are experiencing today during events like the Mother Day Nor'easter of 2008 may end up being the level of a typical high tide in the not too distant future. This will

bring about major changes that will most certainly affect our communities and our way of life.

Saltwater Intrusion

Residents who live farther inland cannot be complacent about sea level rise; it affects much more than just beaches and oceanfront land owners. Higher sea levels can raise below-ground water tables and can increase the salt content of rivers, bays and aquifers. For plants that cannot tolerate salt water, like the lotus lilies in the St. Jones River, rising sea levels and the associated saltwater intrusion may mean an end to their presence in their historic habitats. Fish and other aquatic life also may be affected by changing salinity in our rivers and streams. Food sources may shift with the changing salinity and preferred breeding habitat may no longer be suitable.

Salt water intrusion can also be prob-



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Higher than usual waves hit Port Mahon Road during a November 2009 Nor-easter. Infrastructure and roads on the coast may be the first to be affected by sea level rise, but the impacts of sea level rise will not just be limited to the immediate coastal area.

Bowers Beach Flooding

These maps show the level of high tide in Bowers Beach under three different planning scenarios, which were developed using local data coupled with predictions generated by several federal agencies. Maps showing these scenarios have been developed for the entire state, so you can see what your community might look like during high tides (see next page) of the future.



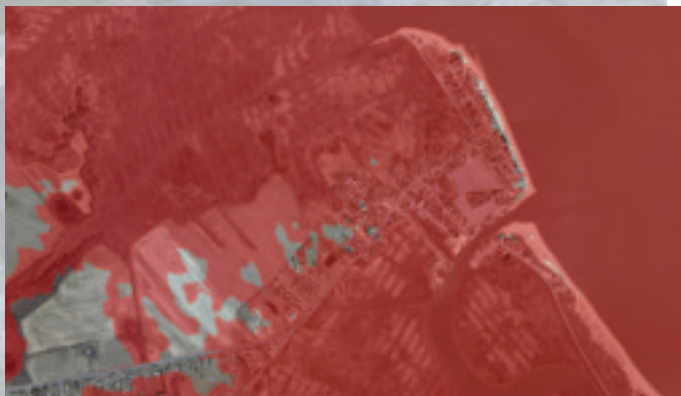
Bowers Beach at high tide, 2010.



Bowers Beach at high tide with 1.6 feet of sea level rise.



Bowers Beach at high tide with 3.3 feet of sea level rise.



Bowers Beach at high tide with 4.9 feet of sea level rise

lematic for drinking water sources. As sea levels rise, saltwater may enter aquifers, contaminating irrigation and drinking water sources.

What DNREC Is Doing

Sea level rise is such an important issue that helping the state prepare for its effects has become a priority focus for DNREC's Delaware Coastal Programs office. For several years, scientists and planners with Delaware Coastal Programs have been conducting research, working with residents and professionals to fill holes in our knowledge and helping communities plan and prepare.

Everyone knows that you can't fix a leak until you've grabbed a flashlight, gotten under the sink and figured out where the leak is coming from. The same goes for preparing for sea level rise. We can't prepare for it until we've shone some light on what the likely problems are going to be and where they will happen.

Because Delaware's tidal marshes may be particularly vulnerable to rising sea levels, Delaware Coastal Programs scientists have set up several studies in cooperation with DNREC's Watershed Stewardship Division, the Center for the Inland Bays and our National Wildlife Refuges. These studies set up new ways of monitoring wetland sediments and vegetation. This will be used to predict how vulnerable each wetland will be to rising sea levels, and to help develop new strategies to manage and protect these valuable habitats.

New strategies will be needed in coastal towns as well, because the real preparation for the effects of rising sea level will happen at the local level. Every day, town and county councils make decisions about where to locate homes, schools and sewer lines and how to fund essential community services. Towns and counties also are partially responsible for emergency planning and response. Increasingly, they will also be responsible for preparing for and dealing with the effects of sea level rise.

Staff from Delaware Coastal Programs has been working one-on-one with the Town of Bowers Beach and the City of New Castle to investigate their potential

Delaware Coastal Programs Online Sea Level Rise Inundation Maps

See for yourself what sea level rise projections have been made for your community. Go to www.dnrec.delaware.gov/Pages/SLRMaps.aspx and enter your address to visualize possible sea level rise inundation scenarios over the next 100 years near you or your favorite places to go across Delaware.



risks from sea level rise and to develop community resiliency plans. The risks to each one of these communities is very different. In Bowers Beach, the projected levels of sea level rise will increasingly flood evacuation routes, the fire station and homes during high tides. On the other hand, in the City of New Castle, a series of dikes currently protects homes and infrastructure, but as the sea level rises, the dikes may become ineffective for flood protection.

These pilot projects show that there is no one-size-fits-all solution and

highlight the need for community involvement. Mayor Hunsicker believes this pilot program has helped the Town of Bowers Beach not only from a planning standpoint, but from a relationship standpoint with the state. "What the state has come up with in this program is fabulous for municipalities because it finally brings everyone under one umbrella, and the planning procedures can go forward."

State agencies also share responsibility for being prepared for sea level rise. DNREC Secretary Collin O'Mara signed

an internal policy that directs DNREC staff to assess the state's land holdings and buildings for potential areas vulnerable to sea level rise. In addition, it directs DNREC staff to consider future sea level rise in planning new projects, whether a wetlands restoration, a boardwalk or a hazardous waste clean-up project. To help with this and other vulnerability assessments, Delaware Coastal Programs, working with technical experts, developed a series of maps that show where the high tide line may be in the future. These maps will be used by the state, local communities and even individuals as a tool to assess their likely risk of future sea level rise.

This fall, Delaware Coastal Programs will form an advisory committee made up of state agencies, business groups, environmental groups and elected officials that will help provide information and feedback to assess Delaware's vulnerability to sea level rise. The committee will then draft and implement recommendations that will help to minimize those risks and help prepare Delaware for tomorrow's new level of high tide.

By taking this step forward, doing research and monitoring, providing assistance to communities, planning with state agencies, and implementing internal changes, DNREC hopes to show that practical steps can be taken now to minimize the impacts of sea level rise in the future and avert major - and more costly - changes to programs and projects.

With this kind of foresight, Delaware will be better able to protect vulnerable species like the lotus lilies, help plan for stronger coastal communities such as Bowers Beach, and better manage our natural resources including Blackbird Creek. **OD**

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